

WHAT IS CLAIMED IS:

1. A method of assisting a wiring design of a wiring structure comprising the steps of:

regarding the wiring structure constituted by a plurality  
5 of pieces of line streak members as an elastic body which has a circular section and in which a plurality of beam elements a linearity of which is maintained are coupled with each other;

applying information concerning a shape characteristic,  
a material characteristic and a constraining condition of the  
10 wiring structure as a predetermined condition to a finite element method;

calculating a predicted shape of the displaced wiring  
structure such that the predetermined condition is satisfied;  
and

15 outputting the calculated predicted shape.

2. The method according to claim 1, wherein the calculating  
step calculates the predicted shape where the wiring structure  
is forcibly displaced so as to satisfy the predetermined  
20 condition.

3. The method according to claim 1, wherein  
- information concerning a change in the shape  
characteristic, the material characteristic and the  
25 constraining condition is provided to the outputted predicted

shape,

a new predicted shape of the forcibly displaced wiring structure is calculated again by utilizing the finite element method, and

5 the new predicted shape is outputted again to enable to verify an optimum shape of the wiring structure.

4. The method according to claim 1, wherein

the wiring structure is a wire harness wired to a vehicle,  
10 the constraining condition is defined by coordinates of respective apexes of the plurality of beam elements and degrees of freedom at the respective apexes,

the shape characteristic is defined by a sectional area and a length of the beam element of the wiring structure, and

15 the material characteristic is defined by a moment of inertia, a polar moment of inertia, a density and a longitudinal modulus of elasticity and a transverse modulus of elasticity of the beam element.

20 5. The method according to claim 1, wherein

in the calculating step, strain and stress of the wiring structure are calculated and

in the outputting step, the calculated strain and stress are outputted together with the calculated predicted shape.

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6. The method according to claim 5, wherein the calculated strain and stress are displayed in multicolor in accordance with values of the strain and stress.

5 7. The method according to claim 5, wherein  
in the calculating step, reaction force and moment produced at a constraining point of the wiring structure are calculated, and

10 in the outputting step, the calculated reaction force and moment are outputted together with the calculated strain, stress and predicted shape.

8. The method according to claim 1, wherein  
in the calculating step, reaction force and moment produced at a constraining point of the wiring structure are calculated, and

15 in the outputting step, the calculated reaction force and moment are outputted together with the calculated predicted shape.

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9. The method according to claim 8, wherein the calculated reaction force and moment are displayed by arrow marks.

10. The method according to claim 1, wherein  
25 in the calculating step, deformation states of the wiring

structure deformed from an arbitrary initial shape to a final shape which satisfies the predetermined condition are successively calculated, and

in the outputting step, the calculated deformation states  
5 of the wiring structure are successively outputted.

11. The method according to claim 10, wherein the deformation states of the wiring structure when predetermined force is applied to a predetermined portion of the wiring structure are  
10 successively calculated and outputted.

12. A method of assisting a wiring design of a wiring structure comprising the steps of:

regarding the wiring structure constituted by a plurality  
15 of pieces of line streak members as an elastic body which has a circular section and in which a plurality of beam elements a linearity of which is maintained are coupled each other,  
calculating an initial shape of the wiring structure based  
on a predetermined bending radius, a constrained position of  
20 the wiring structure, and a constrained direction with respect to the wiring structure at the constrained position as initial value;

providing, to the initial shape, a condition concerning  
a shape characteristic, a material characteristic and a  
25 constraining condition of the wiring structure;

calculating a predicted shape of the forcibly displaced wiring structure such that the provided condition is satisfied by utilizing a finite element method; and

outputting the calculated predicted shape.

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13. The method according to claim 12, wherein

information concerning a change in the shape characteristic, the material characteristic and the constraining condition is provided to the outputted predicted

10 shape,

a new predicted shape of the forcibly displaced wiring structure is calculated again by utilizing the finite element method, and

the new predicted shape is outputted again to enable to  
15 verify an optimum shape of the wiring structure.

14. The method according to claim 12, wherein

the wiring structure is a wire harness wired to a vehicle,

the constraining condition is defined by coordinates of  
20 respective apexes of the plurality of beam elements and degrees of freedom at the respective apexes,

the shape characteristic is defined by a sectional area and a length of the beam element of the wiring structure, and

the material characteristic is defined by a moment of  
25 inertia, a polar moment of inertia, a density and a longitudinal

modulus of elasticity and a transverse modulus of elasticity of the beam element.

15. An apparatus of assisting a wiring design of a wiring  
5 structure in which the wiring structure constituted by a plurality of pieces of line streak members is regarded as an elastic body which has a circular section and in which a plurality of beam elements a linearity of which is maintained are coupled with each other, and a shape of the wiring structure which  
10 satisfies a predetermined condition is predicted by utilizing a finite element method, the apparatus comprising:

a setting unit for setting information concerning a shape characteristic, a material characteristic and a constraining condition of the wiring structure as the predetermined  
15 condition;

a calculating unit for calculating a predicted shape of the displaced wiring structure such that the condition is satisfied by applying the predetermined condition to the finite element method; and

20 an outputting unit for outputting the predicted shape calculated by the calculating unit.

16. The apparatus according to claim 15, wherein the calculating unit calculates the predicted shape where the wiring  
25 structure forcibly displaced so as to satisfy the condition.

17. The apparatus according to claim 15 further comprising a verifying unit which provides information concerning a change in the shape characteristic, the material characteristic and the constraining condition to the predicted shaped output by the outputting unit, calculates again a new predicated shape of the forcibly displaced wiring structure by utilizing the finite element method and makes the outputting unit output the new calculated predicted shape to enable to verify an optimum shape of the wiring structure.

18. The apparatus according to claim 15, wherein the calculating unit calculates strain and stress of the wiring structure, and the outputting unit outputs the calculated strain and stress together with the calculated predicted shape.

19. The apparatus according to claim 15, wherein the calculating unit calculates reaction force and moment produced at a constraining point of the wiring structure, and the outputting unit outputs the calculated reaction force and moment together with the calculated predicted shape.

20. The apparatus according to claim 15, wherein the calculating unit successively calculates states of the wiring structure deformed from an arbitrary initial shape

to a final shape which satisfies the predetermined condition,  
and

the outputting unit successively outputs the calculated  
states of the wiring structure.

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21. The apparatus according to claim 20 further comprising  
a second setting unit for setting predetermined force applies  
to a predetermined portion of the wiring structure as the  
predetermined condition,

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wherein the calculating unit successively calculates the  
deformation states of the wiring structure to which the force  
is applied, and the outputting unit successively updates and  
outputs the deformation state of the wiring structure based  
on the calculated deformation states of the wiring structure.

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22. The apparatus according to claim 20 further comprising  
a temporary stopping unit for temporary stop output by the  
outputting unit by a trigger based on manual operation.

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23. An apparatus of assisting a wiring design of a wiring  
structure in which the wiring structure constituted by a  
plurality of pieces of line streak members is regarded as an  
elastic body which has a circular section and in which a plurality  
of beam elements a linearity of which is maintained are coupled  
with each other, and a shape of the wiring structure which

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satisfies a predetermined condition is predicted by utilizing a finite element method, the apparatus comprising:

a first calculating unit for calculating an initial shape of the wiring structure based on a predetermined bending radius,  
5 a constrained position of the wiring structure and a constrained direction with respect to the wiring structure at the constrained position set as an initial value;

a setting unit for setting a condition concerning a shape characteristic, a material characteristic and a constraining  
10 condition of the wiring structure to the initial shape;

a second calculating unit for calculating a predicated shape of the forcibly displaced wiring structure such that the set condition is satisfied by utilizing the finite element method; and

15 an outputting unit for outputting the predicted shape calculated by the second calculating unit.

24. The apparatus according to claim 23 further comprising a verifying unit which provides information concerning a change  
20 in the shape characteristic, the material characteristic and the constraining condition to the predicted shaped output by the outputting unit, calculates again a new predicated shape of the forcibly displaced wiring structure by utilizing the finite element method and makes the outputting unit output the  
25 new calculated predicted shape to enable to verify an optimum

shape of the wiring structure.

25. A recording medium storing a program which causes a computer to function as an apparatus of assisting wiring design  
5 of a wiring structure in which the wiring structure constituted by a plurality of pieces of line streak members is regarded as an elastic body which has a circular section and in which a plurality of beam elements a linearity of which is maintained are coupled with each other, and a shape of the wiring structure  
10 which satisfies a predetermined condition is predicted by utilizing a finite element method, the program causing the computer to functions as:

a setting unit for setting information concerning a shape characteristic, a material characteristic and a constraining  
15 condition of the wiring structure as the predetermined condition;

a calculating unit for calculating a predicted shape of the forcibly displaced wiring structure by applying the predetermined condition to the finite element method such that  
20 the condition is satisfied; and

an outputting unit for outputting the predicted shape calculated by the calculating unit.

26. The recording medium according to claim 25, wherein the  
25 calculating unit calculates the predicted shape where the wiring

structure is forcibly displaced so as to satisfy the condition.

27. The recording medium according to claim 25, wherein the program causes the computer to calculate strain and stress of the wiring structure, and output the calculated strain and stress together with the calculated predicted shape.

28. The recording medium according to claim 25, wherein the program causes the computer to calculate reaction force and moment produced at a constraining point of the wiring structure, and output the calculated reaction force and moment together with the calculated predicted shape.

29. The recording medium according to claim 25, wherein the program causes the computer to successively calculate deformation states of the wiring structure deformed from an arbitrary initial shape to a final shape which satisfies the predetermined condition, and successively update and output the deformation state of the wiring structure based on the calculated states of the wiring structure.

30. A recording medium storing a program which cause a computer to function as an apparatus of assisting wiring design of a wiring structure in which the wiring structure constituted by a plurality of pieces of line streak members is regarded as

an elastic body which has a circular section and in which a plurality of beam elements a linearity of which is maintained are coupled with each other, and a shape of the wiring structure which satisfies a predetermined condition is predicted by  
5 utilizing a finite element method, the program causing the computer to function as:

a first calculating unit for calculating an initial shape of the wiring structure based on a predetermined bending radius, a constrained position of the wiring structure and a constrained  
10 direction with respect to the wiring structure at the constrained position set as an initial value;

a setting unit for setting a condition concerning a shape characteristic, a material characteristic and a constraining condition of the wiring structure to the initial shape;

15 a second calculating unit for calculating a predicated shape of the forcibly displaced wiring structure by utilizing the finite element method such that the set condition is satisfied; and

an outputting unit for outputting the predicted shape  
20 calculated by the second calculating unit.

31. A method of assisting a wiring design of a wiring structure by calculating a predicted shape concerning a wiring structure constituted by a plurality of pieces of line streak members,  
25 the method comprising the steps of:

successively calculating deformation states of the wiring structure deformed from an arbitrary initial shape to a finale shape; and

successively outputting the calculated states.